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cont.
to produce a final product comprising an alkyl ester and glycerol and wherein said

glycerol leaves the single phase as the glycerol is formed;

wherein the critical fluid is one selected to have a critical temperature within about 20% of

the reaction temperature and a critical pressure as modified by any co-solvent within a range of about

0.5 to about 15 times the reaction pressure.

Double distillation
P. 7
1st
HP

acid base

REMARKS

By this Amendment, claims 1-15 have been cancelled and claims 16-29 have been added.

Accordingly, claims 16-29 are now pending in the present application. The claim amendments are supported by the specification and claims as originally filed, with no new matter being added. Specifically, support for the amendments can be found at page 1, lines 17-21; page 4, lines 12-15; page 5, lines 15-18; page 6, lines 1-4 and 17-22; page 8, lines 18-20; page 9, lines 11-21; and page 10, line 1 to page 11, line 3. Accordingly, favorable reconsideration of the pending claims is respectfully requested.

1. Rejections Under 35 U.S.C. § 112

Claims 1-15 have been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point and distinctly claim the subject matter which Applicants regard as the invention. In particular, the Examiner has indicated that the following terminology renders claims 1-15 indefinite: "ROH input," "containing substances," "critical fluid medium," "alcohol," "catalyst," "final products," "short chain alkyl group," "liquid catalyst," "acid liquid catalyst," "base liquid catalyst," "solid liquid catalyst," and "inorganic oxide." Applicants respectfully traverse.

Because the previously pending claims have been cancelled and new claims have been added, the above rejections are no longer applicable. However, in order to further the prosecution of the case the following explanations of the use of the above terms in the new claims is presented.

Regarding the term "ROH input," it has not been used in the new claims. Rather, the new claims use the term C₁-C₄ short chain alcohol as suggested by the Examiner.

Regarding the term "containing substances," the Applicants have replaced this term with the term "organic compound." A markush group of compounds is provided to add specificity to this term.

The term "critical fluid medium" has been modified in claim 16 by providing a markush group of potential fluids that can utilized. Nevertheless, Applicants reiterate that any suitable material may provide a critical fluid medium depending on the process parameters of the given reaction.

Regarding the terms "alcohol" and "final products," claim 16 now recites "C₁-C₄ short chain alcohol" and "a final product comprising an alkyl ester and glycerol." Accordingly, these terms more specifically recite respective chemicals and are definite.

Regarding the terms "catalyst," "liquid catalyst," "acid liquid catalyst," "base liquid catalyst," "solid catalyst," and "inorganic oxide," the Examiner has rejected these terms because the conditions under which the catalysts are used has not been defined. Although the above terms have in some cases been changed in the new claims and various specific examples are now recited, Applicants respectfully traverse. In particular, the term catalyst is intended to be a broad term because the scope of potential catalysts that can be used is very broad, including a number of potential catalysts that are recited in the specification and the present dependent claims. In fact, it is because of the use of

the critical fluid medium that a wide range of catalysts can be used. *See*, specification at page 4, lines 12-15. The specification is not written to limit the scope of the term "catalyst" and one skilled in the art would therefore not be confused as to the scope or meaning of the term.

Finally, the terms "liquid catalyst" and "solid catalyst" have been replaced by "liquid phase catalyst" and "solid phase catalyst" to further clarify the terms, and specific catalysts have been recited to correspond to various classes of claimed catalysts.

Accordingly, Applicants believe that each term in the newly pending claims is definite and respectfully request that the rejection of the claims under 35 U.S.C. § 112 be withdrawn.

2. Rejections Under 35 U.S.C. § 103(a)

Claims 1-15 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,520,708 to Johnson et al. (hereinafter "*Johnson*"), combined with U.S. Patent No. 4,695,411 to Stern et al. (hereinafter "*Stern*") or U.S. Patent No. 5,578,090 to Bradin (hereinafter "*Bradin*") in view of JP 09157684A Abstract (hereinafter "*JP '684*") and JP 63112536A (hereinafter "*JP '536*"). Applicants respectfully traverse.

The Office Action cites *Johnson*, *Stern*, and *Bradin* for teaching the basic reactions recited in the claims of the present application and cites the *JP '684* and *JP '536* publications for teaching the solubility effects of critical fluids. However, Applicants respectfully point out that the *JP '684* and *JP '536* publications are directed to solubility effects in performing purifications and separations, not reactions. Accordingly, the present claims have been submitted to recite various features of the invention that clarify the use of critical fluids as reaction mediums and not merely as solubility providing fluids.

Regarding this difference between reaction mediums and fluids providing solubility effects, Applicants respectively point out that solubility alone is not enough to promote a more advantageous reaction. For example, fats and oils are also soluble in hexane, but hexane would be a poor reactant medium due to mass transfer limitations. One skilled in the art would therefore not assume that a solubility enhancing fluid is a good reaction medium. Conversely, one skilled in the art looking for a new reaction medium would not look for a fluid with solely good solubility properties. The present invention is based on the surprising discovery that critical fluids impart a number of advantages as a reaction medium, including decreased loss of catalyst or catalytic activity, elimination of mass transfer limitations by maintaining the various reactants in a single phase, and increased potential for use of a wide range of catalysts.

One particularly advantageous feature of the claimed invention is that the critical fluid creates a single phase in which normally immiscible reactants such as water or alcohol and fats or oils combine. Such a feature is not taught or suggested in the cited references. Not only does this feature provide advantages such as reducing mass transfer limitations, speeding the reaction, and the like, but it also enables one of the reaction products, glycerol, to leave the phase wherein the reaction occurs. This feature not only enhances the efficiency of separating the compounds but also increases the rate of reaction by driving the reaction equilibrium of the reactants remaining in the critical fluid phase.

Thus, for the above reasons and because *Johnson, Stern, and Bradin* provide no motivation to seek a reaction medium based solely upon solubility and the *JP '684* and *JP '536* publications teach solubility phenomena alone and do not teach any advantages of a critical fluid as a reaction

medium, one skilled in the art would not be motivated to combine the teachings of the *JP '684* and *JP '536* publications with the teachings of *Johnson*, *Stern*, or *Bradin*.

In addition, claim 28 has been amended to recite the steps of sequentially separating the glycerol and alkyl ester from the final products and critical fluid medium, respectively. These separation steps illustrate an important features of the invention, that a carefully selected critical fluid enables the clean and efficient separation of the glycerol and alkyl ester and also allows the reaction equilibrium to be driven by removal of the glycerol as the reaction progresses.

Claim 29 recites various process conditions and their relation to the selection of a proper critical fluid. In particular, reactions according to claim 29 are performed at a temperature from about 20°C to about 200°C and a pressure from about 150 psig to about 4000 psig. Further, an effective critical fluid is recited as one selected to have a critical temperature within about 20% of the reaction temperature and a critical pressure as modified by any co-solvent within a range of about 0.5 to about 15 times the reaction pressure. Hence, the claim 29 thereby recites a method of selecting appropriate critical fluids for a particular reaction. The cited references have no such teachings of these reaction conditions.

Accordingly, Applicants submit that the claims are patentable for the reasons presented hereinabove and request that the rejection of the claims under 35 U.S.C. § 103(a) be withdrawn.

CONCLUSION

In view of the foregoing, Applicants respectfully request favorable reconsideration and allowance of the present claims. In the event the Examiner finds any remaining impediment to the prompt allowance of this application which could be clarified by a telephone interview, the Examiner is respectfully requested to contact the undersigned attorney.

RESPECTFULLY SUBMITTED

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IN THE SPECIFICATION

The paragraph beginning at page 10, line 13 has been amended as follows:

After completion of the reaction the reaction vessel may be the separation vessel, a final product stream 110 exits the reactor 10 and enters a first product separator 12. In the first product separator 12 the product stream's temperature and/or pressure are modified to allow the least soluble product in the critical fluid to quantitatively drop out, the glycerol in this embodiment. Once the glycerol has dropped out of the critical fluid medium, a physical separation of the two phases can be readily accomplished. A glycerol product stream 112 and a glycerol depleted product stream 114 exits [exists] the first separator 12. The glycerol depleted product stream 114 [112] consists of the critical fluid, excess alcohol, alcohol ester of the glycerides and any remaining catalyst, if a liquid catalyst is used, and then enters a second product separator 14. Again the temperature and pressure of the critical fluid are lowered to allow the desired product, the alkyl ester of the glyceride of this embodiment, to drop out of the critical fluid while retaining the excess alcohol in the critical fluid. The physical separation of the two phases then creates a second product stream of the alcohol ester 116 and the critical fluid recycle 104 which will be reintroduced back into the front of the process after having its pressure and temperature restored to the original input reaction requirements.